

**U.S. DEPARTMENT OF ENERGY
NUCLEAR ENERGY RESEARCH INITIATIVE
ABSTRACT**

PI: Randy Lott

Proposal No.: 99-0128

Institution: Westinghouse Electric Company

Collaborators: Pennsylvania State University, Argonne National Laboratory-W, Idaho
National Engineering & Environmental Laboratory

Title: Fundamental Mechanisms of Corrosion of Advanced Zirconium Based Alloys
at High Burn-Up

Westinghouse Electric Company proposes to collaborate with The Pennsylvania State University and Argonne National Laboratory in a program to develop corrosion resistant zirconium alloys that will allow reliable operation of nuclear fuel assemblies at extended burnup. Extended burnups will allow further improvements in the nuclear fuel cycle in support of the NERI objectives in the areas of nuclear waste, proliferation, economics and safety. The program focuses on building a sound technical basis for the selection of the proposed alloys. This technical basis is important because it helps assure the reliability of the product and provides a foundation for further technical advancements. A sound fundamental understanding of the mechanisms of corrosion may be used to develop control measures for these important degradation mechanisms. The proposed program will provide both the materials and the technical basis for an irradiation-testing program separately proposed for the Advanced Test Reactor. The Idaho National Engineering and Environmental Laboratory will provide consultation on the design of test reactor irradiation programs and zirconium alloy specimens.

A variety of traditional and advanced techniques will be used to characterize oxides on a series of corrosion tested zirconium alloys. Alloy compositions and processing will be carefully controlled to facilitate a study of the variables determining corrosion performance. The proposed characterization techniques include:

- Comparative Corrosion Rate Tests of Irradiated and Unirradiated Specimens
 - X-ray Diffraction and Fluorescence Studies of Oxide Films using the Advance Photon Source at Argonne
 - Transmission Electron Microscope Studies of Oxide Films
 - Electrochemical Impedance Spectroscopy
 - Transmission Electron Microscope Studies of Irradiated Zr Alloys
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In addition, a series of electrochemistry and radiolysis studies will be conducted at Argonne National Laboratory. The results of the characterization studies will be incorporated into a model of zirconium alloy corrosion. The model will be used to evaluate the significance of proposed corrosion mechanisms and to identify the role of alloy additions on corrosion behavior. The effect of irradiation on the corrosion mechanisms will be evaluated in the context of the model.

The knowledge generated in this program will be used to develop advanced, corrosion resistant zirconium alloys. The program will provide the basis of the irradiation-testing program that will be required to verify the in-core corrosion performance of these alloys. By the third year of the program, baseline information on the corrosion behavior of a wide variety of zirconium alloys will be established and material will be selected for an irradiation program in the Advanced Test Reactor.